NATIONAL URANIUM TAILINGS PROGRAM

Canada

FISH STUDY FOR THE NATIONAL URANIUM TAILINGS PROGRAM (NUTP)

NUTP-85-4 (TR)

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SUMMARY

This report is designed to pull together fish data generated as a result of work done under the National Uranium Tailings Program. This material was difficult to access in its original form. By collating it in the form presented in this report, it is more readily accessible by researchers.

SOMMAIRE

Ce rapport est une compilation de tous les résultats analytiques sur les études de poissons générées par le Programme national de recherche sur les résidus d'uranium. Ces études étaient diversifiées et difficiles à obtenir. Il nous a donc fallu les assembler sous une forme facilement disponible et comprenable.

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1. INTRODUCTION

Because of the availability of historical data on fish, the National Uranium Tailings Program (NUTP) decided not to implement a major fish study as part of its research program. However, one contract, to collect and establish bioaccumulation factors into benthic organisms, did trap fish as part of the project (1). These fish had their stomach content analyzed to establish which zoobenthic organisms they were feeding on. This information was then used to assist in the design of the sampling plan for the zoobenthic organisms themselves.

After use, the fish samples were labeled, frozen and stored.

2. OBJECTIVES OF THE FISH STUDY

Most of the previous work done on fish had included the analysis of radium-226 and total uranium. Very little data was available on lead-210 and the thorium isotopes. Some workers had established that these isotopes, particularly the thorium series, had a significant impact on the final dose to man via the aquatic food chain pathway. On investigation it was revealed that to calculate these doses to humans the researchers had made a considerable number of assumptions. Not the least of these assumptions were the concentration of thorium daughters in fish flesh.

If these assumptions were invalid it would alter the calculated dose substantially. The NUTP felt that this issue had to be resolved. It was therefore decided to take the existing fish samples and analyze for a suite of radionuclides. If their presence was established in sufficiently high quantities to merit concern then a more major fish study would be undertaken.

It was felt the fish taken under the zoobenthic organisms study had been sampled at appropriate locations. Most of the fish came from areas impacted by uranium mining in the Elliot Lake district, and the other half came from similar areas in Northern Saskatchewan. Some fish were taken from Dunlop Lake, Ontario which has never been affected by mining activity. The only significant problem was that the sample was rather small.

3. INVOLVEMENT OF THE MINISTRY OF THE ENVIRONMENT OF ONTARIO

Throughout the zoobenthic organisms study the NUTP received considerable assistance from the Ministry of the Environment of Ontario. Discussions with MOE revealed that more radionuclide analysis on Elliot Lake fish would be desirable. Also, MOE collected a number of white suckers, but again the sample was too small. By pooling our resources, both groups would be able to obtain the data required for fish from the Elliot Lake district of Ontario. Therefore, it was agreed that two separate programs would be undertaken for the analyses of these fish, one funded by NUTP and the other by MOE. Each program, although separate, would be coordinated with the other and both groups would benefit by exchanging the results.

4. RESULTS

The two sets of fish samples were pooled and fish were divided into two portions, fish flesh and skin and bones. Each sub-sample in the fish was analyzed for lead-210, thorium-228, thorium-230, thorium-232, gross alpha, gross beta activity and radium-226. The analyses were carried out by Dr. Gene Smithson of the Saskatchewan Research Council.

The results obtained are shown in Table 1.

Table 1

RESULTS OF FISH STUDY (NUTP and MOE)

July 1985

* SAMPLE LOCATION	FISH NUMBER	FISH TISSUE	SAMPLE WET WEIGHT (g)	ASH WEIGHT	PERCENT ASH	Pb 210	Th 228	Th 230	Th 232	+GROSS ALPH	+GROSS BETA	+ Ra 226 TOTAL
Dunlop Lake	2/6	skin/bone	819.8	51.9	6.3	0.03	<0.02	0.09	<0.02	2.0	5.0	0.04
Dunlop Lake	2/6	flesh	540.2	5.9	1.1	0.05	<0.02	<0.02	<0.02	8.3	18.2	0.02
Dunlop Lake	10/3	skin/bone	965.8	64.5	6.7	0.05	<0.02	<0.02	<0.02	2.5	4.4	0.005
Dunlop Lake	10/3	flesh	657.0	10.2	1.6	<0.04	<0.02	<0.02	<0.02	8.6	17.0	<0.005
Dunlop Lake	5/4	skin/bone	894.9	54.9	6.1	<0.04	<0.02	<0.02	<0.02	1.6	3.4	0.01
Dunlop Lake	5/4	flesh	587.1	5.7	0.97	0.06	<0.02	<0.02	<0.02	8.5	18.3	<0.005
Esten Lake	1	skin/bone	470.3	29.2	6.2	0.06	<0.02	<0.02	<0.02	1.3	2.3	0.10
Esten Lake	1	flesh	502.5	4.9	0.98	<0.04	<0.02	<0.02	<0.02	7.4	16.5	0.03
Esten Lake	2	skin/bone	494.9	28.2	5.7	0.03	<0.02	<0.02	<0.02	1.1	2.5	0.07
Esten Lake	2	flesh	504.1	5.9	1.2	0.09	<0.02	<0.02	<0.02	6.5	16.5	0.04
Esten Lake	3/4	skin/bone	1060.2	60.3	5.7	0.04	<0.02	0.02	<0.02	2.2	3.0	0.09
Esten Lake	3/4	flesh	666.0	6.1	0.92	0.08	<0.02	<0.02	<0.02	5.1	12.0	0.01
Depot Lake	8	skin/bone	524.8	33.2	6.3	<0.04	<0.02	<0.02	<0.02	2.2	2.3	0.10
Depot Lake	8	flesh	431.3	3.9	0.90	<0.04	<0.02	0.09	<0.02	5.9	14.8	0.03
Depot Lake	5	skin/bone	503.1	35.1	7.0	<0.04	<0.02	<0.02	<0.02	2.0	2.3	0.04
Depot Lake	5	flesh	434.9	3.6	0.82	<0.04	<0.02	<0.02	<0.02	5.9	13.8	0.06
Depot Lake	3	skin/bone	523.9	33.1	6.3	0.09	<0.02	<0.02	<0.02	2.4	2.6	0.09
Depot Lake	3	flesh	452.3	3.8	0.84	0.12	<0.02	<0.02	<0.02	7.8	13.9	0.03
Quirke Lake	2/6/10	skin/bone	595.0	39.7	6.7	1.1	<0.02	<0.02	<0.02	3.9	3.8	0.03
Quirke Lake	2/6/10	flesh	399.7	3.6	0.9	0.17	<0.02	<0.02	<0.02	6.9	18.3	0.02
Quirke Lake	4/7	skin/bone	597.5	37.6	6.3	1.5	<0.02	<0.02	<0.02	3.5	5.3	0.11
Quirke Lake	4/7	flesh	398.2	4.0	1.0	0.13	<0.02	<0.02	<0.02	6.4	15.2	0.03
Quirke Lake	1/3/5/8/9	skin/bone	421.0	30.1	7.1	0.60	<0.02	<0.02	<0.02	2.4	3.0	0.08
Quirke Lake	1/3/5/8/9	flesh	355.9	3.8	1.1	0.06	<0.02	<0.02	<0.02	9.4	17.0	0.11
McCarthy Lake	3/6/7/8	skin/bone	329.7	25.5	7.7	0.06	<0.02	<0.02	<0.02	1.3	2.6	0.21
McCarthy Lake	3/6/7/8	flesh	342.6	2.9	0.85	<0.04	<0.02	<0.02	<0.02	5.3	14.4	0.02
McCarthy Lake	4/9/10	skin/bone	390.8	26.6	6.8	0.06	<0.02	<0.02	<0.02	1.2	2.7	0.08
McCarthy Lake	4/9/10	flesh	362.6	3.5	0.97	0.03	<0.02	<0.02	<0.02	6.5	18.2	0.04
McCarthy Lake	1/2	skin/bone	560.4	37.9	6.8	0.25	<0.02	<0.02	<0.02	1.7	3.0	0.07
McCarthy Lake	1/2	flesh	371.2	3.4	0.92	0.04	0.03	0.30	0.03	5.5	15.0	0.02
						Bq/g	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g

* All lakes near the town of Elliot Lake, Ontario
+ Ministry of the Environment of Ontario data

4.1 ASSESSMENT OF THE RESULTS

The thorium isotopes were below the detection level for all fish except for three anomalies. One fish was high in all isotopes in the flesh fraction (McCarthy Lake, Ontario), a second was elevated in thorium-230 in the skin and bone fraction (Dunlop Lake, Ontario) and a thorium-230 level is higher than the detection limit in the flesh fraction of a fish from Depot Lake, Ontario. These results suggest that thorium uptake into fish flesh is very limited. Calculated values from assumed transfer coefficients or other means are not valid and thus the contribution to total dose from the thorium isotopes is likely to be insignificant.

Measurable values of lead-210 do occur in McCarthy and Quirke Lakes samples. This is not surprising as these are lakes that are the most affected by uranium mining operations. However, even these levels are not particularly high. Overall half the values are less than 0.05 Bq/g and, indeed, two thirds of the values are below 0.06 Bq/g.

Similarly, none of the values for radium-226 are high enough to warrant further attention.

5. CONCLUSION

None of the values obtained for the isotopes analyzed in this study justify an additional fish program for the purposes of the NUTP. The NUTP will use the data generated by this study and in previous research programs as input to the mathematical models. It is recognized that this is not a definitive study, but given the resources available to the NUTP, there are other research areas that have a higher priority. Within the objectives of the NUTP the existing data is considered adequate.

6. OTHER COMMENTS

Information included in this report is directly comparable to data contained in the report on zoobenthic organisms (1). Fish remaining from this contract were given to Saskatchewan Environment and the Ministry of the Environment of Ontario. It is their plan to continue to do further work on these specimens.

The NUTP also agreed to support a project to develop biological reference materials for uranium and its radioactive daughters. Two potential sources of radionuclide-bearing organic material were chosen. One was spruce needles from an area with known high background levels of radionuclides in the soil. This material was collected and subsequently proved to be a useful reference standard (2-4). In addition, 150kg of bottom-feeding fish were collected from Wollaston Lake in Northern Saskatchewan (5). Unfortunately, subsequent analyses proved that these fish were not sufficiently high in radionuclide concentrations to make an acceptable standard (6-8). Attached to this document as Appendix "A" is a report by J. L. Dalton (Scientific Authority for this biological reference materials project) which gives details on the project and a summation of the radionuclides analyzed. It is worth noting that the analytical values obtained from these fish are representative of 150kg of bottom-feeding fish.

7. REFERENCES

(1) SENES Consultants Limited, 1985 (in association with Saskatchewan Research Council) - "A Study of the Distribution of Naturally-Occurring Radionuclides in Freshwater Benthos and Their Environment - Phase I and II". Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.
Contract Serial No. OSQ83-00241.

(2) Dunn, C. E., 1984 - "Information Concerning Vegetation Collected as Biological Reference Material for Uranium and Radionuclides". Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.
Contract Serial No. OSQ84-00114.

(3) Chemex Labs Limited, 1985 (in association with Saskatchewan Research Council) - "Radiochemical Analysis of Vegetative Reference Materials CLV-1 and CLV-2". Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.
Contract Serial No. OSR84-00216.

(4) Monenco Analytical Laboratories, 1985 - "Radiochemical Determinations in Vegetative Reference Materials II (NUTP)". Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.
Contract Serial No. OSR84-00217.

(5) Minor Bay Camps, 1984 - "Collection of Bottom-Feeding Fish from Wollaston Lake, Saskatchewan".
Contract Serial No. OSQ84-00084.

(6) Technical University of Nova Scotia, 1984 - "Fish-Based Reference Materials" - Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.
Contract Serial No. OST84-00166.

(7) Chemex Labs Limited, 1985 - "Analysis of Fish Meal for Radionuclides - I" - Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada. Contract Serial No. OSR84-00205.

(8) Monenco Analytical Laboratories, 1985 - "Analysis of Fish Meal for Radionuclides - II" - Report to the National Uranium Tailings Program, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada. Contract Serial No. OSR84-00207.

APPENDIX "A"

BIOLOGICAL REFERENCE MATERIALS

for the

NATIONAL URANIUM TAILINGS PROGRAM

1. FISH MEAL

BIOLOGICAL REFERENCE MATERIALS FOR THE NATIONAL URANIUM TAILINGS PROGRAM

1. FISH MEAL

by

J. L. Dalton*

The Analytical Subcommittee of the Canadian Uranium Producers Metallurgical Committee approached the National Uranium Tailings Program (NUTP) to prepare radionuclide reference materials from biological materials such as wildlife, fish, vegetative material, etc., as there is no known reference material of this type certified for naturally-occurring radioisotopes. The NUTP agreed to provide funds for the preparation of two types of reference materials, fish and vegetation. This report deals with the efforts expended in the preparation of the fish material. The bulk of the analytical work was to be done by commercial laboratories with support work by the Chemical Laboratory of CANMET.

After considerable consultation with resource personnel, it was decided to collect approximately 150kg of bottom-feeding fish from Wollaston Lake in Northern Saskatchewan. Wollaston Lake is in an area known to contain elevated levels of uranium and is adjacent to the Rabbit Lake uranium mining operation. Mr. Gerald Howard of Minor Bay Camps was engaged to collect the fish under Contract Serial No. OSQ84-00084 dated July 11, 1984. Mr. Howard collected and froze approximately 150kg of bottom-feeding fish which were shipped to Halifax for processing with a stop-over in Ottawa to ensure retention of the frozen state. The cost of these services was $1,500.

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Dr. Gordon Bligh, of the Canadian Institute of Fisheries Technology, Technical University of Nova Scotia at Halifax, N.S., was engaged to process the fish under Contract Serial No. OST84-00166 dated July 25, 1984, for a cost of $10,379. The processing consisted of separation of fleshy tissue from bone, dehydration of both tissue and bone, milling of the materials, extraction of the fish oil from the various portions and homogenization of all fractions. The contract stated that three reference materials were to be delivered; namely protein meal, bone meal and fish oil.

It was apparent that a decision had to be made at the start of the processing operation. There was concern that the removal of the fish oil with acetone would also extract the radionuclides. On the other hand, to leave the fish oil in the material may render the material rancid with time. Accordingly, a bench scale processing investigation was carried out and Dr. Bligh forwarded five test samples to the Chemical Laboratory (CANMET) for analysis. These test samples were analyzed for gamma-activity and uranium content. The measurements made at that time indicated that the pertinent concentrations were less than the detection limit. This situation now required another decision to be made; whether to proceed with the project or stop at this point. It was decided to continue with the processing and to select the oil extraction procedure so that the material would have a reasonable shelf-life. Dr. Bligh proceeded with the preparatory work and delivered approximately 20kg of fish bone meal, an equal quantity of fish protein meal and a small quantity of extracted fish oil. Dr. Bligh's comprehensive report is on file and available if required.

As there now were considerable financial resources expended in the project, it was thought necessary to have two commercial laboratories confirm the Chemical Laboratory's analytical work. Accordingly, Chemex Labs of Vancouver, B.C. under Contract Serial No. OSR84-00205 and Monenco Analytical Laboratories of Calgary, Alberta under Contract Serial No. OSR84-00207 were engaged to provide analytical work for a total cost of $2,628. The analytical results obtained are shown in Table A-1 and agree

in substance with those obtained by CANMET. The contractors analytical reports are on file and available if required.

It is not anticipated that any further analytical work will be carried out on the two meal products unless there is a demonstrated demand for a biological material which could almost be regarded as a reagent blank for naturally-occurring radionuclides. The material cannot be used for the purpose intended as the concentration of the natural radionuclides is far too low to attempt to assign analytical values with a practical uncertainty statement. However, the concentration of Cs-137 is high enough to warrant certification if necessary. There are commercially available reference materials certified for this radionuclide (A-1), but of somewhat different matrix.

As a matter of scientific curiosity, the Radiation Protection Bureau (RPB) of the Department of Health and Welfare was asked to carry out a uranium determination on the solutions that had been prepared for the uranium determination by the CANMET method. Although both methods use the fluorometric measurement, the RPB method separates the uranium from the other constituents present in the solution. The results obtained are shown in Table A-2, and do indeed indicate that the acetone extraction may remove a substantial portion of the radionuclide content. However, it is doubtful whether the material could have served as a viable reference material for naturally-occurring radionuclides even if the acetone extraction had not been carried out as the concentration levels are still quite low.

It should be pointed out that information obtained from this study may have some value in environmental studies. The analytical values obtained are produced from representative samples from a batch of approximately 150kg.

REFERENCE

(A-1) National Bureau of Standards, Washington, D.C.
Reference Materials 4355 and 43508

Table A-1

Analytical Results Obtained from Commercial Laboratories
Bq/g

Fish Protein	Pb-210	Po-210	Th-230	Ra-226	Cs-137	U ppm	
Chemex	.013	.005	.01	.003	.11	.03	.04
	.012	.008	.01	.003	.11	.04	.03
						.03	
						.04	
Monenco	<.03	.007	.00027	<.0005		<.1	
	<.03	.008	.00036	<.0005		<.1	
Fish Bone							
Chemex	<.01	.005	<.01	.003	.030	.10	.11
	<.01	.007	<.01	.003	.032	.09	.09
						.09	
						.09	
Monenco	<.03	.007	.00013	.00062		<.1	
	<.03	.007	<.0001	.00085		<.1	

Table A-2

Analytical Results Obtained by Radiation Protection Bureau

Sample	U (ppm)
Dehydrated Bone	0.69
Dehydrated Bone, Acetone Wash	0.066
Dehydrated Skin Scales	0.20
Dehydrated Skin & Scales Acetone Wash	0.078
Muscle Acetone Wash	0.054

ADDITIONAL NOTE

Re: Fish Study for the NUTP (NUTP 85-4 (TR))

Judging from the replies I have received to date, there seems to be some misunderstanding on the intent of the document "Fish Study for the National Uranium Tailings Program (NUTP)", NUTP 85-4 (TR). To resolve this confusion, I would like to clarify a number of points.

First, the fish were collected under a contract entitled: "A Study of the Distribution of Naturally-Occurring Radionuclides in Fresh Water Benthos and their Environments - Phase I and II". Once collected, their stomach contents were examined so that appropriate decisions could be made on which species of benthic organisms would be most important for the field sampling program. Although not wanted for further work under the benthic contract, the fish carcasses were frozen for potential future use. However, appropriate details on water quality, etc. are contained in the Phase II final report of this benthic study. Organizations, such as AECL, Atomic Energy Control Board and Environment Canada, who have members on our Technical Advisory Committee, can obtain a copy by contacting their representative. Those wishing to have their own copy of Phase II can order it from Micromedia Limited, 158 Pearl Street, Toronto, Ontario, M5H 1L3 quoting Micromedia Order Number 85-5173 and CANMET (DSS) Serial No. OSQ83-00241.

Second, the major objective of the NUTP is to produce a mathematical predictive model. This model should be, as much as possible, a working, useable tool that will allow others to predict the long-term effects of any specific site on the environment. It is not our intention to provide a final close-out assessment for any site. That is the responsibility of the site owner. To that end, it is not necessary for us to have detailed data for all pathways and all conditions at all sites, but simply an adequate understanding of the typical distribution of data. This will enable us to demonstrate the effectiveness of our mathematical model. Within these limitations, and within the limitations of our resources, we cannot see any need for further work on thorium isotopes to meet the objective for the NUTP. Detailed investigations into the variation of radionuclide uptake with fish species, sex and the full range of environmental conditions, is beyond the scope of our Program.

We would, of course, be delighted to hear of results from programs justified with other reasons. (Unfortunately, the NUTP has a specific Treasury Board mandate and cannot fund other Federal Government department research programs.) Recently, for example, I received a letter from Mr. Ron Barsi of Saskatchewan Environmental

giving additional results on the fish collected by us in Wollaston Lake, Saskatchewan. Again, Mr. Barsi's data can be used in conjunction with the data contained in the benthic report.

Thirdly, the fish's original sample weight is given in the fourth column of Table 1. The ash weight from that sample is given in column 5 and the results of the analysis of the ash are given in column 7 through 13.

In summary:

1. Fish samples were obtained during a research contract to investigate zoobenthic organisms.

2. The fish samples were preserved.

3. Sufficient funds were gathered between NUTP and MOE to have a limited analytical program on the Ontario fish.

4. The analytical results were sitting in a file unavailable to others. As the fish was sampled in a scientific manner along with appropriate water, sediment samples, etc. it was felt the results might be of value to others. Therefore, they were published and distributed.

If you have any further questions, do not hesitate to call me.

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